1.0 Scope

1.1 Scope

This Organizational Work Instruction (OWI) addresses operations of the oxygen supply system for Marshall Space Flight Center's (MSFC's) Building 4623 that are the responsibility of the Building 4623 contractor. System equipment external to Building 4623 maintained by MSFC's propellants and pressurants service contractor. Components of the system inside Building 4623 are operated and monitored by the Building 4623 contractor.

1.2 Purpose

The purpose of Building 4623's oxygen supply system is to provide a facility-wide source of gaseous oxygen (GOX) to the test cells located in Building 4623.

1.3 Applicability

This instruction applies to the Chemistry Team, Materials Test Branch, of the Materials and Processes Laboratory.

2.0 Applicable Documents

CVI Operational & Maintenance Manual: High Pressure Cryogenic Reciprocating Pump.

EM10-OWI-CHM-050, *Building 4623 Guidelines for General Operations.*

LOX Tank Fill and Maintenance Procedures. Chart Service Manual #10960582.

MPR 1840.2. *MSFC Hazard Communications Program*.

MPR 1840.3. *MSFC Hazardous Chemicals in Laboratories Protection Program*.

MPR 8715.1. *Marshall Safety, Health, and Environmental (SHE) Program.*

MPR 8823.2. *Pressure Systems Guidelines and Certification Requirements*.

MSFC-SPEC 164B. *Cleanliness of Components for Use in Oxygen Fuel and Pneumatic Systems Specification*.

MWI 8715.2B. *Lockout/Tagout Program*.

MWI 8715.4. *Personal Protective Equipment (PPE).*

MWI 8715.15. *Ground Operations Safety Assessment and Risk Mitigation Program*

Note: Personnel **shall** always **reference** the current version of an applicable document.

3.0 Definitions

3.1 Definitions

NASA Marshall Space Flight Center EM10 responsible personnel

Lockout/Tagout Placement of a tag-out device on an energy isolating device to indicate that the energy-isolating device and equipment being controlled must not be operated until the tag-out device is removed by the authorized person who placed it there

3.2 Acronyms

AN Army/Navy
C Connection
CGA Compressed Gas Association
CV Check Valve
FC Fill Connection
GOX Gaseous Oxygen
HCV Hand Control Valve
LI Level Indicator
LOX Liquid Oxygen
MSFC Marshall Space Flight Center
NASA National Aeronautics and Space Administration
OWI Organizational Work Instruction
PBC Pressure Building Coil
PCC Pressure Control Valve
PI Pressure Indicator
PSE Pressure Safety Element
PSV Pressure Safety Valve
ROV Remote Operations Valve
S Strainer
TSV Thermal Safety Valve
VAP Vaporizer
VP Vacuum Port
VR Vacuum Readout

(Figure 4-5).

4.0 Instructions

Refer to Figure 4-1. 4-2. and 4-3 for vessel flow diagrams and valve nomenclatures. This information is also located in the manufacturer's service manual #10960582 and is affixed to the tank. Figures 4-4 and 4-5 illustrate the LOX pump control panel located on the oxygen supply system pad and the Oxygen System Master Control Panel inside Building 4623, respectively.

4.1 System Startup Procedure

4.1.1. Initial Startup

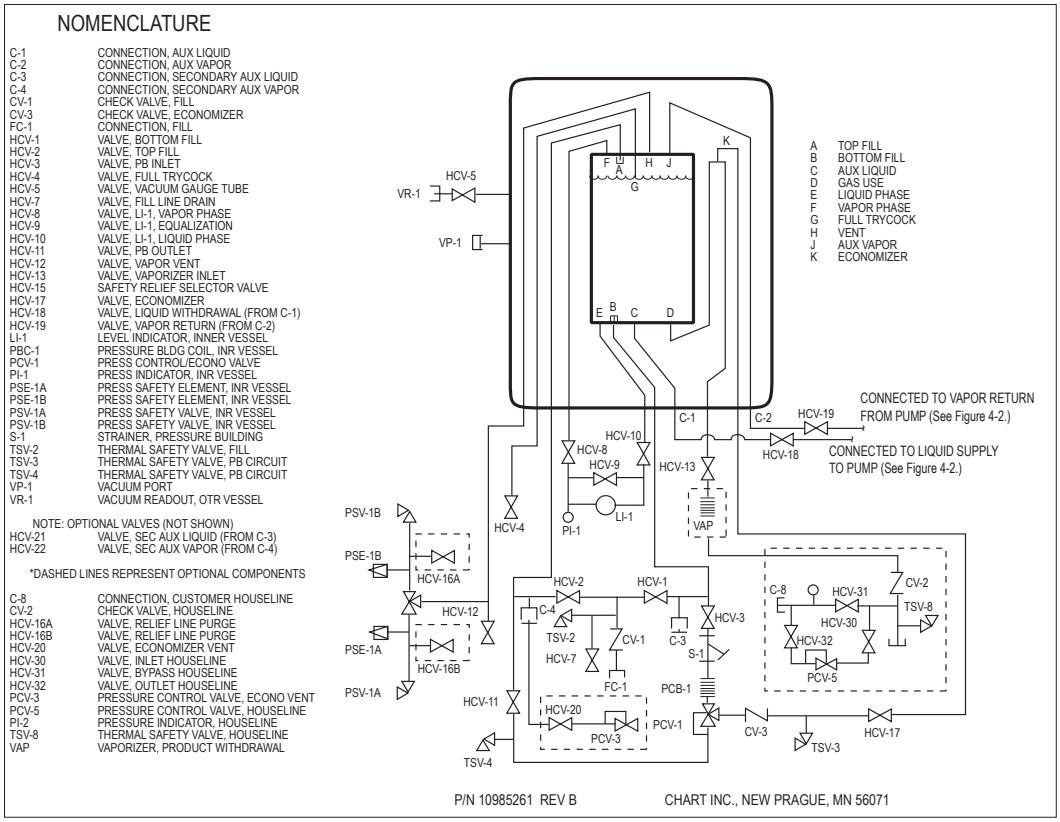
The system operator shall perform the following steps:

4.1.1.1. **Check** and **record the** Facility Supply Pressure as indicated on the Oxygen Supply Master Control Panel (Figure 4-5).

4.1.1.2. At the LOX pump control panel (Figure 4-4):

- **Ensure** the circuit breaker handle is in the **ON** position.
- **Place** the **OFF RESET/ON RUN** switch in the **ON RUN** position.
- **Insert** key into the **SYSTEM CONTROL** switch, and **place** it in the **AUTO** position.

Figure 4-1. Flow Diagram C-10985261 from the CVI PD3000 service manual



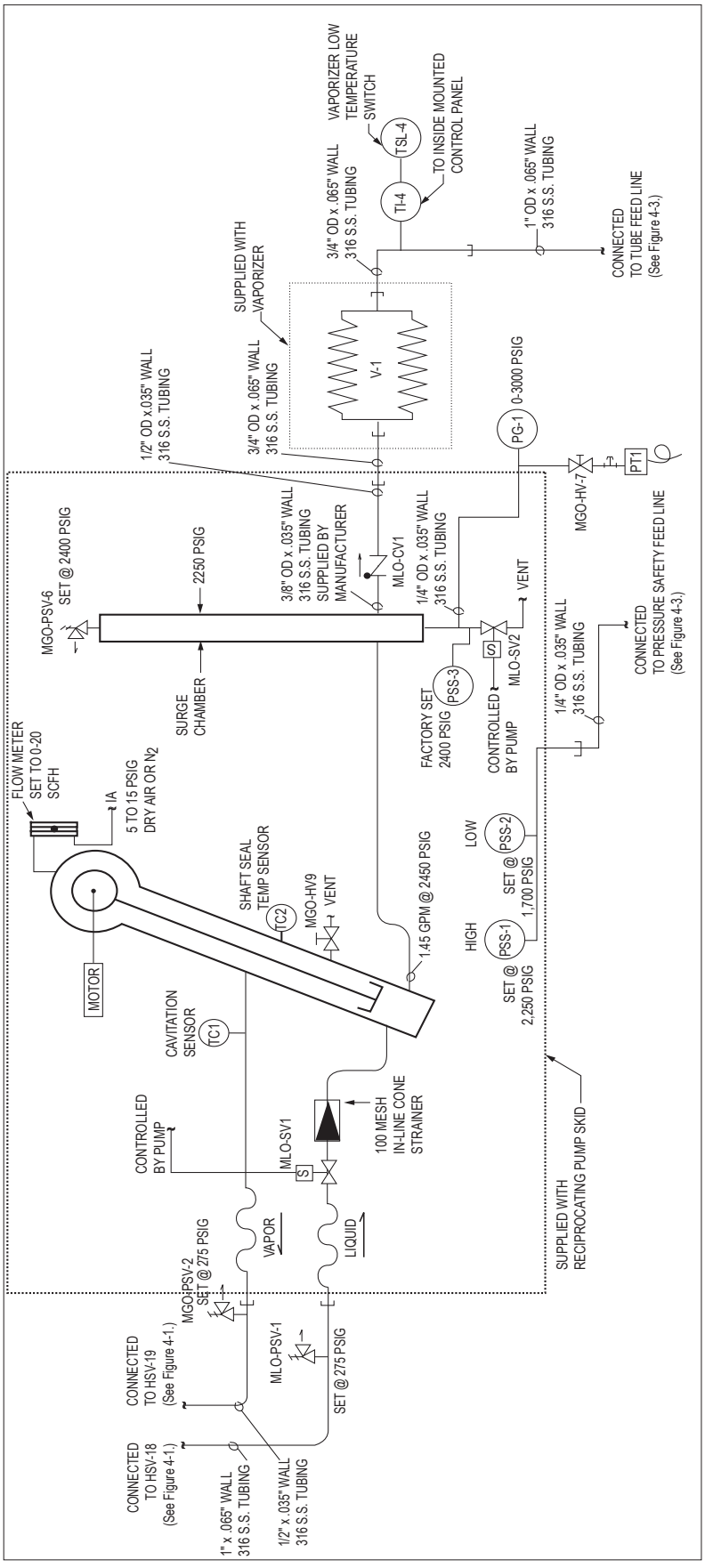


Figure 4-2. Schematic, Detail B, from MSFC Drawing Building 4623 LOX/GOX Conversion and Storage System

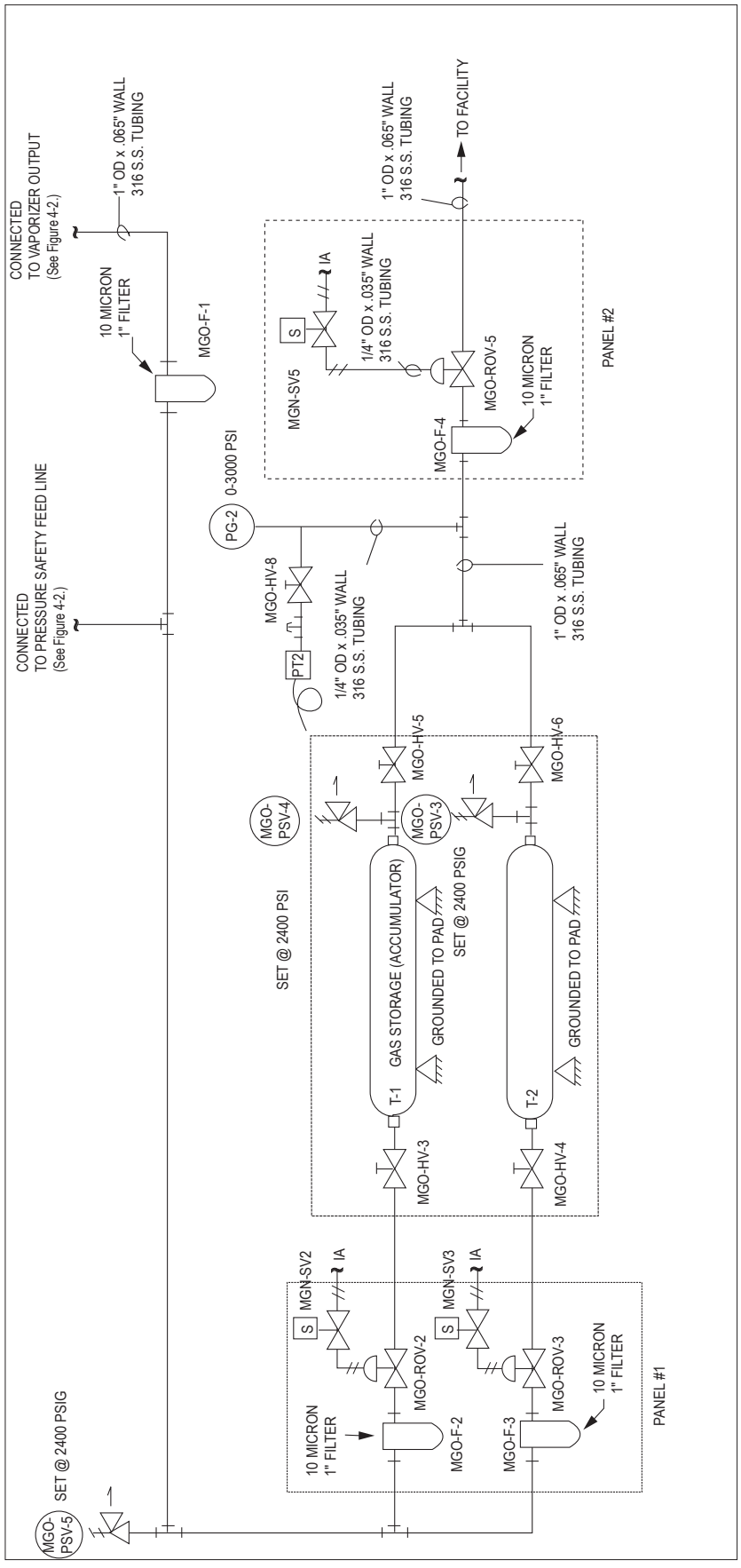


Figure 4-3. Schematic, Detail C, from MSFC Drawing Building 4623 LOX/GOX Conversion and Storage System

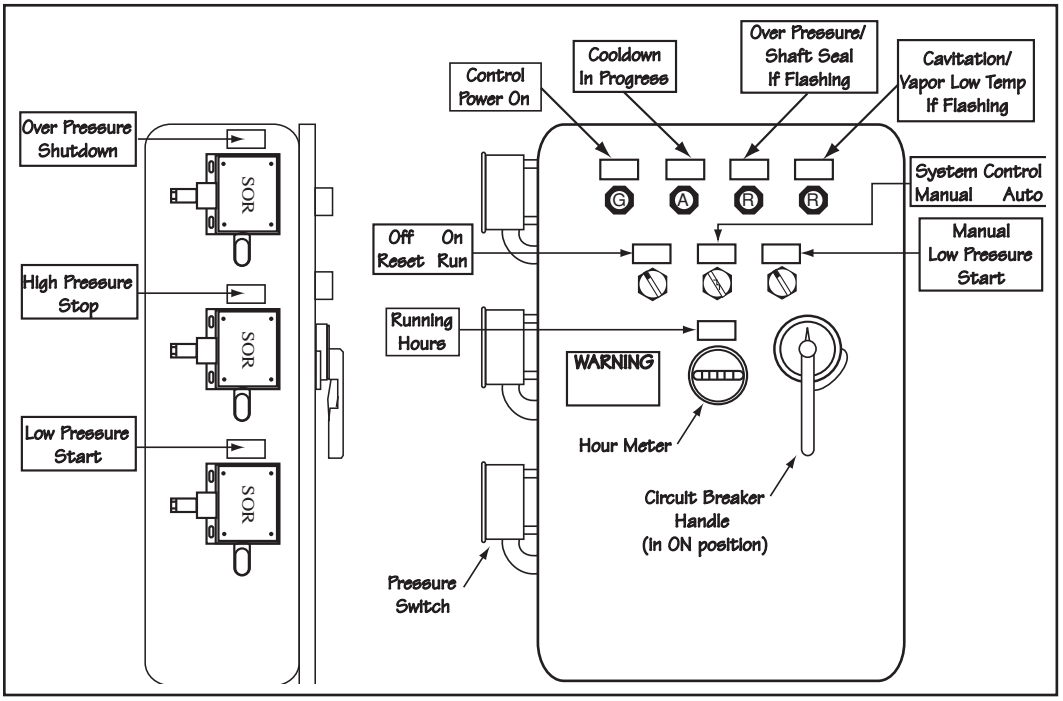


Figure 4-4. LOX Pump Control Panel.

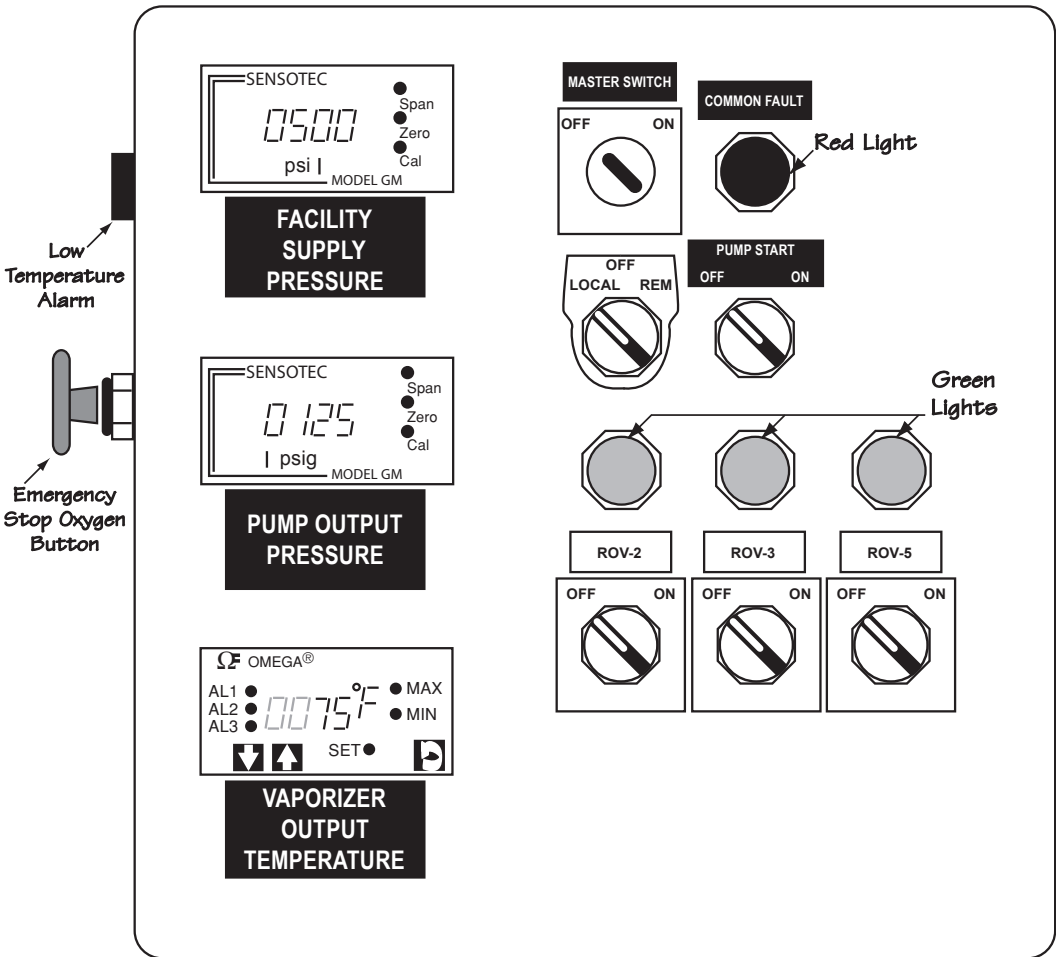


Figure 4-5. Oxygen Supply Master Control Panel inside Building 4623.

Note: Illustrations are representative.

- **Fully open** vapor return valve **HCV-19 AUX VAPOR** (located on the LOX tank) by turning it counterclockwise.
- **Open** the sump bleed hand valve (Figure 9-4) approximately one complete turn counterclockwise.
- **Fully open** liquid withdrawal valve **HCV-18 AUX LIQUID** (located on the LOX tank) by turning it counterclockwise.
- **Ensure** that the pump crank case purge regulator (Figure 9-4) is set to 15 psig maximum and the crank case purge flow meter (Figure 9-4) is set between 0 and 20 scfh.
- **Ensure** that GOX storage tube isolation hand valves **HV-3** and **-4** (Figure 9-2 inset) and **HV-5** and **-6** (Figure 9-3) are open fully by turning each fully counterclockwise.

Note: Once **HV-3, -4, -5,** and **-6** are opened for the first system startup, they are to be tagged open and not to be closed unless maintenance is to be performed on the system and/or tubes.

4.1.1.3. At the Oxygen System Master Control Panel (Figure 4-5):

- **Ensure** that the red **EMERGENCY OXYGEN STOP BUTTON** is in the out position.
- **Open** the Oxygen System Master Control Panel door with the key.
- **Insert** key into the **MASTER** switch, and **place** it in the **ON** position.
- **Place** the **LOCAL/REM** switch in the **LOCAL** position.
- **Place ROV-2, ROV-3,** and **ROV-5** in the **ON** position in this order. The green light directly above each switch illuminates to indicate the "on" condition.
- **Place** the **PUMP START** switch in the **ON** position.

4.1.1.4. At the pump:

- Once cold gas is observed exiting the sump bleed hand valve (Figure 9-4), **fully close** the valve by turning it clockwise.
- **Exit** the LOX station pad, and **secure** the fenced area.

Note: When the pump has reached its desired cool-down temperature, it enters a 5-minute hold time and then begins to operate automatically. The pump is designed to maintain a continuous supply of GOX to the facility from 1,500 to 2,250 psi.

4.1.2. Normal Operation

Once initial start up is performed, the pump is designed to operate automatically without the need of personnel at the station.

CAUTION: Some cryogenic gas lines on the oxygen system pad are not insulated, specifically, the line between the pump and vaporizer (Figure 9-4). The operator **shall use** caution when in the vicinity of these lines to avoid skin contact with the metal.

The system operator shall perform the following steps:

4.1.2.1. To ensure that the system is ready for operation at all times, **inspect** it periodically to discover and correct defects before they result in serious damage or failure.

4.1.2.1.1. Before each operation, **inspect** the system for tampering or damage that may have occurred since the system was operated last.

4.1.2.1.2. During operation, **be alert** for signs of any degradation in performance or other abnormal operation. **Document** daily check in the maintenance log. **Check** for:

- Unusual noises
- Overheating of shaft bearings
- Belt slippage
- Excessive vibrations
- Failure to respond to controls.

If any of these are observed during operation, the operator **shall shut down** the system for further inspection or repair.

4.1.2.2. The LOX system is equipped with a series of fail-safes to protect the system from damage. Any of these fail-safes will immediately disable the pump and will be displayed as a "Common Fault" on the Oxygen System Master Control Panel, indicated by a red light.

- Cavitation (detected by a thermocouple located on the vapor phase return line)
- Shaft seal failure (detected by a thermocouple located in the shaft seal housing compression fitting)
- Vaporizer output low temperature (detected by a thermocouple on the vaporizer output tubing). Temperature is also monitored at the Oxygen System Master Control Panel inside Building 4623.

4.1.2.3. The vaporizer output low temperature warning also disables the pump and sets off an audible alarm on the Oxygen System Master Control Panel inside Building 4623.

4.2 System Shutdown Procedure

The system operator shall perform the following actions:

4.2.1. Temporary Shutdown. **Stop** the pump by placing the **PUMP START** switch on the Oxygen System Master Control Panel in the **OFF** position.

4.2.2. Overnight Shutdown. **Stop** the pump by placing the **PUMP START** switch on the Oxygen System Master Control Panel in the **OFF** position. **Close** the

liquid withdrawal valve **HCV-18 AUX LIQUID** at the tank by turning it fully clockwise.

4.2.3. Permanent Shutdown/Maintenance Shutdown

4.2.3.1. For shutdowns of extended periods of time with no maintenance being performed, momentarily **crack** the vapor return valve **HCV-19 AUX VAPOR** at the tank to slightly pressurize the station system to prevent possible contamination.

Note: Initial System Startup shall be performed after long period shutdowns. (**See** section 4.1.1.)

4.2.3.2. For shutdowns involving maintenance to the pump only:

4.2.3.2.1. **Stop** the pump by placing the **PUMP START** switch in the **OFF** position at the Oxygen Supply Master Control Panel.

4.2.3.2.2. **Close** liquid withdrawal valve **HCV-18 AUX LIQUID** at the tank by turning fully clockwise.

4.2.3.2.3. **Open** the sump bleed hand valve (Figure 9-4) by turning it fully counterclockwise to vent the sump's residual liquid to the atmosphere.

4.2.3.2.4. **Open** the pump's main breaker (Figure 9-4) by rotating it clockwise to the **OFF** position; **lock** it in the **OFF** position. **Lockout/tagout** the pump in accordance with MWI 8715.2, *Lockout/Tagout Program* (current revision).

4.2.3.2.5. After the system has warmed, **close** vapor return valve **HCV-19 AUX VAPOR** at the tank by turning it fully clockwise.

4.2.3.2.6. **Close** the sump bleed hand valve (Figure 9-4) by turning it fully clockwise to prevent contamination.

4.2.3.2.7. At the Oxygen Supply Master Control Panel, **close ROV-2** and **ROV-3** by placing the selector switches in the **OFF** position, indicated by the extinguishing of the green light above each.

4.2.3.3. Shutdown involving planned maintenance and/or the addition of connections or components to the facility GOX supply line shall be scheduled with the NASA and contractor management team (COTR and contractor lead engineer.)

CAUTION: This is an oxygen system; all equipment to be connected to this system shall be cleaned to MSFC-SPEC 164B Class 1, Level A, and certified for oxygen service.

4.2.3.3.1. **Unlock** the Oxygen Supply Master Control Panel with the key.

4.2.3.3.2. **Place** the **PUMP START** switch in the **OFF** position.

4.2.3.3.3. **Place ROV-5** in the **OFF** position; **ensure** that the green indicator light above it goes off.

4.2.3.3.4. **Close** and **lock** the Oxygen Supply Master Control Panel, and **remove** the key.

4.2.3.3.5. **Vent** the GOX supply line pressure to atmosphere through a test chamber. (**Consult** the OWI governing operations for the test chamber.)

4.2.3.3.6. **Check** the reading on the **FACILITY SUPPLY PRESSURE** meter at the Oxygen Supply Master Control Panel. **Verify** that the reading is **0** psig before performing any maintenance or connection/component additions.

4.2.3.3.7. Once maintenance and/or additional connections/components have been performed, **ensure** all supply valves entering the facility are closed.

4.2.3.3.8. At the GOX tubes on the pad, **close HV-5** and **HV-6** handtight.

4.2.3.3.9. **Unlock** the Oxygen Supply Master Control Panel using the key.

4.2.3.3.10. **Place ROV-5** in the **ON** position; the "on" condition is indicated by the green light illuminating.

4.2.3.3.11. Slowly **crack HV-5** until the facility supply line is completely pressurized. When the supply line is charged, **open HV-5** and **HV-6** by turning each valve fully counterclockwise.

4.2.3.3.12. **Open** the corresponding isolation valve to purge the facility GOX supply line to atmosphere for approximately 1 minute through the newly installed connection/component.

4.2.3.3.13. **Stop** the purge by closing the corresponding isolation valve.

4.2.3.3.14. **Place** the **PUMP START** switch in the **ON** position.

4.2.3.3.15. **Close** and **lock** the Oxygen Supply Master Control Panel, and **remove** the key.

4.2.4. Emergency Shutdown and Reset

The system is designed with two emergency shutdown techniques. After emergency shutdown, the digital pressure gauges and vaporizer output temperature will continue to function, allowing the system to be monitored.

4.2.4.1. Automatic Shutdown: The oxygen supply system is designed to automatically shut down when the facility fire alarm is activated.

Note: There is no fire alarm system to indicate a fire on the oxygen system pad itself. In the case of fire on the pad, **manually activate** the facility fire alarm, one of which is located to the left of the Oxygen Supply Master Control Panel, by pulling down the handle, and then **depress** the large red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel. **Evacuate** the building in accordance with the Building 4623 Safety Plan.

4.2.4.2. Manual Shutdown. The oxygen supply system can be shut down by depressing the large red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel. The **EMERGENCY OXYGEN STOP BUTTON** is designed to interrupt power to the Oxygen Supply Master Control Panel.

4.2.4.3. Resetting after Emergency Shutdown

WARNING: Only authorized personnel shall be allowed to reset (pull out) the **EMERGENCY OXYGEN STOP BUTTON**.

Note: When the **EMERGENCY OXYGEN STOP BUTTON** is reset, the system will restart in its last configuration.

After an emergency situation has caused a shutdown of the system, the system shall be reset in accordance with the following steps:

4.2.4.3.1. **Open** the Oxygen Supply Master Control Panel door with the key.

4.2.4.3.2. **Place** the **MASTER SWITCH** in the **OFF** position, using the correct key.

4.2.4.3.3. **Leave** the **LOCAL/REM** switch in the **LOCAL** position.

4.2.4.3.4. **Place** the **PUMP START** switch in the **OFF** position.

4.2.4.3.5. **Place ROV-2, ROV-3,** and **ROV-5** in the **OFF** position in this order.

4.2.4.3.6. **Pull out** the **EMERGENCY OXYGEN STOP BUTTON**.

4.2.4.3.7. **Place** the **MASTER SWITCH** in the **ON** position.

4.2.4.3.8. **Place ROV-2, ROV-3,** and **ROV-5** in the **ON** position in this order. **Verify** that the green light directly above each switch illuminates.

4.2.4.3.9. **Place** the **PUMP START** switch in the **ON** position.

Note: The pump may go into the cool-down cycle, depending on the duration of the shutdown. The pump will not start until the desired temperature (-75 °F to -175 °F) is reached, as determined by thermocouple TSL-1, located on the vapor phase return tubing. This cool-down process may take 15 minutes, depending on the tubing configuration and the outside temperature.

4.3 Data Recording

Before daily shutdown of the system and before the next day's startup, the system operator **shall record** Facility Supply Pressure as indicated on the Oxygen Supply Master Control Panel (Figure 4-5). The system operator **shall maintain** the daily record in the maintenance log as a tool for early detection of possible system leaks.

5.0 Notes

Custodians for EM10-OWI-CHM-057	
Master List and Document Control	EM10 Management Support Assistant
Alternate Document Control	EM10 Group ISO Representative
Records	Materials Test Branch ISO Representative
Memoranda	Materials Test Branch ISO Representative

6.0 Safety Precautions and Warning Notes

6.1 Hazards

Warning
Death, severe personal injury, or loss of major equipment may result if maintenance or operating procedures, techniques, restrictions, etc., are not followed exactly.

Safety shall have precedence over all activities. The oxygen supply system involves several hazards to the system operator and facility. These hazards include:

- Pressurized systems (oxygen)
- Potential for exposure to oxygen-enriched environment
- Possible shock hazard from electrical components
- Potential touch temperature risks from cryogenic temperatures (LOX)

6.2 Safety Precautions

The system operator shall:

6.2.1. **Plan** oxygen supply activities so at least one other person is in Building 4623 during normal business hours. After business hours or on weekends, a test engineer shall be present during all activities.

6.2.2. **Wear** appropriate PPE during all cryogenic fluids handling and transfer:

- Goggles
- Face shield
- Thermal gloves
- Long-sleeved shirt/jacket

6.2.3. Good safety practices dictate that a damaged or suspect container be carefully emptied as soon as possible. Under no circumstances shall a damaged container be left with product in it for an extended period of time. Furthermore, a damaged or suspect container shall not be refilled unless the unit has been repaired and recertified.

6.2.4. In the event of known or suspected container vacuum problems, **do not continue to use this unit**. Continued use of a container that has a vacuum problem can lead to embrittlement and cracking. Further, the carbon steel jacket could possibly rupture if the unit is exposed to inordinate stress conditions caused by an internal liquid leak.

6.2.5. Before reusing a damaged container, the unit shall be tested, evaluated, and repaired as necessary. It is highly recommended that any damaged container be sent to the manufacturer for repair and recertification.

6.2.6. LOX shall not be allowed to spill onto any asphalt surfaces.

6.2.7. LOX filling shall not be performed (1) during inclement weather when lightning is possible and rain may cause moisture contamination of the system, (2) if lightning is visible, or (3) if the lightning Emergency Warning System sounds.

6.2.8. Smoking shall not be permitted during LOX transfer and/or within a 50-ft radius around the LOX station.

6.2.9. LOX filling shall not be permitted until the LOX pump is placed in stand-by mode. Stand-by mode prevents the pump from cycling during the tanks-filling process. The LOX pump shall remain in stand-by mode until all personnel are clear of the area.

6.2.10. **Serious tissue damage can occur** with exposure to cryogens, cold vapors, or cold equipment. *If injury occurs,* **dial 911** immediately, and **request** medical assistance. Bystanders can **(but are not required to)** do the following:

- *If it is safe to do so*, **remove** the person from the source of cold.
- *In the case of massive full-body cryogenic exposure*, *if it is safe to do so*, **remove the person** from the exposure atmosphere, and **keep the person's airway open**. **Loosely wrap the person** in a blanket until medical personnel arrive.
- **Do not remove** frozen gloves, shoes, or clothing.
- **Do not massage** affected part(s).
- **Do not expose** affected part(s) to temperatures above 112 °F (45 °C).
- **Do not apply** ice, snow, or ointments to affected part(s).

6.3 Special Precautions

6.3.1. **No one shall be allowed within a 20-ft radius of the LOX station while the LOX pump is running.** A red beacon flashes to indicate that the pump is cycling. This will not be a continuous situation since the pump is used only to recharge the ASME tubes with GOX. The pump cycles only when the supply pressure is below 1,800 psi and shuts down when the supply reaches approximately 2,250 psi.

6.3.2. No vehicles shall be permitted to enter the fenced area behind Building 4623 until the LOX pump is placed in stand-by mode.

6.3.3. Some cryogenic gas lines on the LOX/GOX pad are not insulated, specifically, the line between the pump and vaporizer (Figure 9-4). All personnel shall **use** caution when in the vicinity of these lines to avoid skin contact with the metal.

6.4 LOX Leak

Note: Only GOX-system certified personnel shall be permitted to access the LOX/GOX pad in the event of a LOX leak.

Note: Other personnel noticing a leak **shall not approach** the pad and **shall notify** GOX-system certified personnel, the lead Building 4623 engineer, the Building 4623 Safety Monitor, or the MSFC contractor for pressurants and propellants. (The telephone number for the pressurants and propellants contractor is recorded in the GOX System Maintenance Log.) Once the pressurants and propellants contractor has been notified, **perform** emergency shutdown of the system by depressing the red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel.

In event of a LOX leak, the system operator shall:

6.4.1. **Perform** temporary shutdown of the GOX system: **stop** the pump by placing the PUMP START switch on the Oxygen System Master Control Panel in the OFF position.

6.4.2. **Don** cryogenic gloves, laboratory coat, goggles or face shield before accessing the pad to assess the leak.

6.4.3. **Determine** the severity of the LOX leak.

6.4.3.1. *If both the leak and the controlling valve can be seen and the valve can be closed without obvious risk,* **close** the controlling valve, and **contact** the MSFC pressurants and propellants contractor to secure the system.

6.4.3.2. *If the leak cannot be seen or if the controlling valve cannot be seen or if it is obvious that approach to the controlling valve is hazardous, e.g.,* danger from splashing LOX, **do not approach** the leak area. **Contact** the pressurants and propellants contractor to secure the system; the telephone number for the pressurants and propellants contractor is recorded in the GOX System Maintenance Log. **Perform** an emergency shutdown of the system by depressing the red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel.

6.5 Emergency Shutdown

The system is designed with two emergency shutdown techniques. The digital pressure gauges and vaporizer output temperature will continue to function allowing the system to be monitored.

6.5.1. Automatic Shutdown: The facility oxygen supply system is designed to automatically shut down in the event of a facility fire. The system will shut down when the facility fire alarm is activated.

Note: There is no fire alarm system to indicate a fire on the oxygen system pad itself. In the case of fire on the pad, **manually activate** the facility fire alarm, one of which is located to the left of the Oxygen Supply Master Control Panel, by pulling down the handle, and then **depress** the large red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel. **Evacuate** the building in accordance with the Building 4623 Safety Plan.

6.5.2. Manual Shutdown. The facility oxygen supply system can be shut down by depressing the large red **EMERGENCY OXYGEN STOP BUTTON** located on the left side of the Oxygen Supply Master Control Panel.

WARNING: The **EMERGENCY OXYGEN STOP BUTTON** is designed to interrupt power to the Oxygen Supply Master Control Panel. Only authorized personnel are allowed to reset (pull out) the **EMERGENCY OXYGEN STOP BUTTON.**

6.6 Accident Reporting

6.6.1. In case of fire, **pull** the alarm, and **exit** to the safe location specified in the emergency procedures and plans for Building 4623.

6.6.2. From a safe location, the *test operator* **shall immediately call 911** and **notify** the EM10 Safety Monitor. (**Call** 544-4357 if using a cell phone.)

6.6.3. From a safe location, the *EM10 Safety Monitor* **shall immediately report** the accident to the NASA Safety Monitor and the appropriate supervisor(s).

6.7 Emergency Response Plan

Emergency procedures and plans for Building 4623 are incorporated into this OWI and are stated in MPR 1040.3G. *MSFC Emergency Program. Plans* shall be modified if operations change in a significant manner.

6.8 Mishap Reporting

Personnel **shall report** all mishaps occurring in Building 4623 to the test engineer, who shall report the mishap to the area coordinator/Safety Monitor. An initial verbal report shall be made within 8 hours, followed by a written report within 3

days. The EM10 Safety Monitor shall prepare a managerial report within 7 days. Both reports shall be reviewed by the technician's supervisor and by the NASA Safety Monitor. The detail and extent of the mishap report shall depend on the nature and extent of the damage. *If personal injury or equipment damage does occur,* the mishap report shall be completed in accordance with MWI 8621.1 *Mishap/Incident Reporting and Investigation*.

7.0 Attachments, Data, Reports, and Forms

7.1 Attachments

The following attachments pertain to system activities that fall outside the responsibilities of the Building 4623 contractor. These activities are included as attachments, however, to permit a thorough understanding of the facility oxygen system. These activities will be performed by MSFC's propellants and pressurized systems service contractor.

7.1.1. Preparing the Tank: When preparing the tank for filling or when changing service:

7.1.1.1. **Inspect** the vessel for possible damage or unsuitability for intended use. *If damage is detected, e.g., serious dents, lose fittings,* **remove** the unit from service, and **perform** repairs as soon as possible.

7.1.1.2. **Fill** the vessel by pumping or pressure transfer. *If the vessel pressure is at 50 psi less the maximum allowable pressure of the supply unit,* **transfer** liquid by pressure transfer. *If normal working pressure of the station is equal to or greater than the maximum allowable pressure of the supply unit,* **pump** liquid into the tank.

7.1.1.3. **Purge** the vessel when changing service or to remove moisture or foreign matter from the tank or tank lines. **Use** a small amount of new product for purging when changing service and a small amount of the same product if the purge is to ensure purity or remove contaminants.

7.1.1.4. When changing service, the approved CGA (or other keyed) fitting must be installed for connection FC-1. (**See** Figure 4-1.)

7.1.2. Vessel Purging Procedure

7.1.2.1. **Check** relief valve set pressure on tank to determine the maximum pressure before starting this purge operation.

7.1.2.2. **Ensure** that the maximum purge pressure is equal to 50 percent of the maximum operating pressure of the tank or 30 psi, whichever is less.

Note: To prevent drawing atmospheric contaminates into the tank, always maintain a positive pressure of at least 5 psi in the tank.

7.1.2.3. **Attach** the source of liquid purge to fill connection FC-1.

7.1.2.4. **Close** all valves except:

- Pressure build-up valves HCV-3 and HCV-11
- Liquid level gauge vapor-phase valve HCV-8
- Liquid-phase shut-off valve HCV-10.

Note: Pressure build-up regulator PCV-1 is normally set to build pressure to 120 psi. When this pressure is used as the purge pressure, **do not adjust** the regulator adjusting screw.

7.1.2.5. **Open** hose drain valve HCV-7, and **allow** the source to vent through the hose. **Vent** until a slight frosting appears on the hose. **Close** hose drain valve HCV-7.

7.1.2.6. **Open** bottom fill valve HCV-1 enough to allow the liquid to flow slowly into the tank through the bottom fill line. The gradual flow enables the liquid to vaporize in the line and in the pressure buildup coil and to build up pressure slowly in the inner tank.

7.1.2.7. **Shut off** the liquid supply source when the pressure in the tank reaches the maximum purge pressure as indicated on tank pressure gauge PI-1.

7.1.2.8. **Slowly open** fill line drain valve HCV-7 to avoid splashing the liquid. **Drain** all liquid from the tank. The appearance of gas (vapor) at the drain indicates that all liquid has been drained from the tank.

7.1.2.9. **Close** drain valve HCV-7 and bottom fill valve HCV-1.

7.1.2.10. Before closing the liquid level gauge vapor phase and liquid phase shut-off valves (HCV-8 and HCV-10), **open** liquid level gauge equalization valve HCV-9 to prevent damage to the gauge. When all liquid is drained, **close** liquid level gauge vapor phase valve HCV-8 and liquid phase shut-off valve HCV-10.

7.1.2.11. **Loosen** the unions on either side of the liquid level gauge LI-1. **Open** wide both the upper and lower liquid level gauge valves (HCV-8 and HCV-10), and **visually check** the gas streams for signs of moisture. *If no moisture is observed after blowing the lines for approximately 2 minutes,* **close** both valves. I*f moisture is observed in the gas stream,* **discharge** the gas until it is clear of all moisture.

Note: A careful check for moisture in the phase lines will ensure trouble-free operation of the liquid level gauge. Because of their small diameter, gauge lines are easily plugged by ice.

7.1.2.12. **Open** vapor vent valve HCV-12 and the full trycock valve HCV-4. **Vent** top fill valve HCV-2 by opening hose drain valve HCV-7.

7.1.2.13. **Repeat** purge procedure steps 7.1.2.5 through 7.1.2.9 and step 7.1.2.12 at least three times to ensure product purity.

7.1.2.14. **Reconnect** liquid level gauge LI-1, **open** liquid level control valves HCV-8 and HCV-10, and then **close** bypass valve HCV-9.

7.1.2.15. After purging the tank but before filling, **verify** that the following valves are in the position indicated in Table 7-1.

Table 7-1. Valve Positions to Verify before Filling Tank.

Valve	Designator	Position
Bottom Fill Valve	HCV-1	Closed
Top Fill Valve	HCV-2	Closed
Vapor Vent Valve	HCV-12	Closed
Full Trycock Valve	HCV-4	Closed
Liquid Level Gauge Equalization Valve	HCV-9	Closed
Gas Use Valve	HCV-13	Closed
Pressure Build Inlet/Outlet Valve	HCV-11, HCV-3	Closed
Economizer Isolation Valve	HCV-17	Closed
Liquid Level Gauge Liquid Phase Valve	HCV-10	Open
Liquid Level Gauge Vapor Phase Valve	HCV-8	Open
Hose Drain Valve	HCV-7	Closed

7.1.3. Initial Filling Procedure. The initial fill is usually performed on an empty vessel that has not been in use for an extended period. The container must be purged to ensure product purity.

7.1.3.1. **Purge** the tank to assure product purity (**See** section 7.1.2).

7.1.3.2. **Verify** that the content of the supply unit is the proper product to be transferred.

7.1.3.3. **Verify** that all valves except liquid phase high HCV-10 and gas phase low HCV-8 are closed.

7.1.3.4. **Connect** the supply unit transfer hose to tank fill connection FC-1.

7.1.3.5. **Cool** the transfer hose before filling by opening hose drain valve HCV-7 and venting the supply unit through the hose for approximately 3 minutes. **Close** drain valve HCV-7.

7.1.3.6. **Open** bottom fill valve HCV-1 slowly.

7.1.3.6.1. *If a pressure transfer is to be made,* **allow** pressure to build in the liquid supply unit until it is at least 50 psi higher than the station pressure. **Open** the discharge valve on the supply unit to begin flow.

7.1.3.6.2. *If a pump transfer is to be made,* **make** the required connection to the pump. **Open** the supply unit transport discharge valve slowly. **Maintain** the pump discharge pressure from 50 psi to 100 psi higher than the tank pressure. **Fill** slowly.

7.1.3.7. **Monitor** pressure in the tank during filling. *If pressure rises above supply pressure or near relief valve pressure,* **vent** the tank through vapor vent valve HCV-12. *If the pressure continues to rise,* **interrupt** the fill to allow the pressure to drop.

7.1.3.8. **Monitor** liquid level contents gauge LI-1. When the gauge indicates approximately 3/4 full, **open** the full trycock valve HCV-4.

7.1.3.9. When liquid spurts from full trycock valve HCV-4, **immediately stop fill** at the source, and **close** full trycock valve HCV-4.

7.1.3.10. **Close** bottom fill valve HCV-1.

7.1.3.11. **Drain** residual liquid in the fill hose via drain valve HCV-7.

7.1.3.12. **Relieve** the fill hose pressure by loosening the hose at the fill connection, and then disconnecting the hose. **Allow** the fill hose to defrost to prevent moisture from being drawn inside the hose.

7.1.4 Vessel Refilling Procedure

Note: Filling a cryogenic vessel through the bottom tends to raise pressure in the vessel as gasses in vapor spaces are compressed. Filling through the top tends to lower pressure as gasses in headspace are cooled and reliquefied.

7.1.4.1. **Verify** that the content of the supply unit is the proper product to be transferred.

7.1.4.2. **Verify** that bottom and top fill valves HCV-1 and HCV-2 are closed.

7.1.4.3. When refilling the LOX tank at Building 4623, it **is not necessary** to verify a minimum required operating pressure in the vessel because the system is not operating during the fill procedure.

7.1.4.4. **Verify** that all other valves are in their normal operating positions, as indicated in Table 7-1.

7.1.4.5. **Connect** the supply unit transfer hose to tank fill connection FC-1.

Note: Cool and **purge** the transfer hoses before filling by opening hose drain vale HCV-7 and the supply unit discharge valve for approximately 3 minutes or until the hose begins to frost. **Close** drain valve HCV-7.

7.1.4.6. **Open** top fill valve HCV-2 completely.

7.1.4.6.1. *If a pressure transfer is to be made,* **allow** pressure to build in the liquid supply unit it is at least 50 psi higher than station pressure. **Open** the discharge valve on the supply unit to begin flow.

7.1.4.6.2. *If a pump transfer is to be made,* **make** the required connections to the pump. **Open** the supply unit transport discharge valve slowly. **Close** the pump circulating valve slowly, so as not to lose pump prime. **Maintain** pump discharge pressure from 50 psi to 100 psi higher than tank pressure.

7.1.4.7. **Monitor** pressure in the vessel.

7.1.4.8. **Monitor** liquid level contents gauge LI-1. When the gauge indicates approximately 3/4 full, **open** the full trycock valve HCV-4.

7.1.4.9. When liquid spurts from the full trycock valve HCV-4, **stop** fill at the source, and **close** full trycock valve HCV-4.

7.1..4.10. **Close** tank fill valves HCV-1 and HCV-2.

7.1.4.11. **Drain** residual liquid in the fill hose via drain valve HCV-7.

7.1.4.12. **Relieve** fill hose pressure by loosening the hose at fill connection FC-1, and then **disconnect** the hose.

7.2 Forms

Form 7-1, Maintenance/Repair Log, shows a representative form used to record maintenance activities on the oxygen supply system.

MAINTENANCE/REPAIR LOG
Oxygen Supply System
Building 4623

Date/Time: _____

Reported by: _____ Repair #:: _____

Reason for Maintenance: _____

Description of problem if other than routine maintenance:

_____
_____
_____
_____
_____
_____
_____
_____

Action taken:

_____
_____
_____
_____
_____
_____
_____

Action performed by: _____

Materials used and source:

_____
_____
_____

ICRC/Qualis Engineer Concurrence: _____

NASA/EM10 Facility Reprsentative Approval:_____

Figure 7-1.
Sample Maintenance/Repair Log

Note: Illustration is representative. Actual appearance may vary.

8.0 Records

Records for Building 4623 shall consist of (a) memoranda that contain test results and that are stored electronically in the Materials and Processes Technical Information System (MAPTIS) and (b) calibration records.

8.1 Memoranda

Memoranda containing test results shall be retained indefinitely by EM10. These memoranda shall be stored electronically in the MAPTIS database and shall be accessible by test request number or memorandum number.

8.2 Calibration Records

All equipment requiring calibration shall be in current calibration, in accordance with EM10-OWI-CHM-050, *Building 4623 Guidelines for General Operations.*

8.3 Maintenance of Records

8.3.1. Memoranda less than 10 years old shall be maintained in ready-access files in MAPTIS; memoranda 10 years old or older shall be automatically transferred to historical files.

8.3.2. Calibration records shall be maintained on site for a minimum of 10 years, filed and indexed by test request number. These shall be stored in a manner that will protect them, *e.g.*, in a test folder stored in a metal file cabinet. After 10 years, calibration records shall be transferred to historical files.

8.3.3. The original test records shall be saved for a minimum of 5 years.

9.0 Tools, Equipment, and Materials

9.1 Equipment

The Building 4623 oxygen supply system is composed of a LOX tank, LOX pump, vaporizer, two GOX storage tubes, and related control and delivery fixtures. A fenced and locked area behind Building 4623, houses the external equipment that converts LOX to GOX and maintains the facility's supply of GOX at pressures up to 2400 psi. GOX lines run from the ASME storage tubes, through a grate-covered trench, and into Building 4623 where the gas is distributed to test stations conducting combustion research activities.

Figures 9-1, 9-2, 9-3, 9-4, and 9-5 show components of the oxygen supply system located in the fenced area behind Building 4623. The following sections describe components of the system.

9.1.1. LOX Tank.

The LOX tank comprises an alloy steel inner tank encased in an outer carbon steel vacuum shell. The insulation system between the inner and outer containers consists of composite insulation and high vacuum to ensure long holding time. The units have a tank pressure relief device that is set at the factory. The inner tank (54 in. outer diameter) has a liquid capacity of 967 gal (gross warm) and 900 gal (net cold). The outer tank has an outer diameter of 66 in. The system has a flow capability of 6,600 scfh/nm^3/hr.

The tank is leg mounted. Controls to operate the system are mounted under and on the sides of the station.

The normal operating pressure range of the tank is 50 to 250 psi. Tank operation is governed by the pressure build-up system and the economizer system. The tank's single regulator system doubles as an economizer regulator and pressure building regulator. The economizer regulating function allows vapor space gas to be introduced preferentially into the final line or gas use circuit when the station pressure exceeds the regulator setting. The pressure building circuit maintains a minimum set pressure in the vessel.

9.1.2. LOX Pump (Figures 9-4 and 9-5). The high-pressure cryogenic pump is designed to maintain a continuous supply of GOX to the facility from 1,500 to 2,250 psi. Once the pump has reached its desired cool-down temperature, it operates automatically. When the pump is operating, the red warning beacon (located on the Remote Operations Panel beside the GOX storage tubes) will flash.

9.1.3. Vaporizer (Figure 9-1). The ambient vaporizer is a stainless-steel lined aluminum-finned unit, with a design pressure rating of 3500 psig.

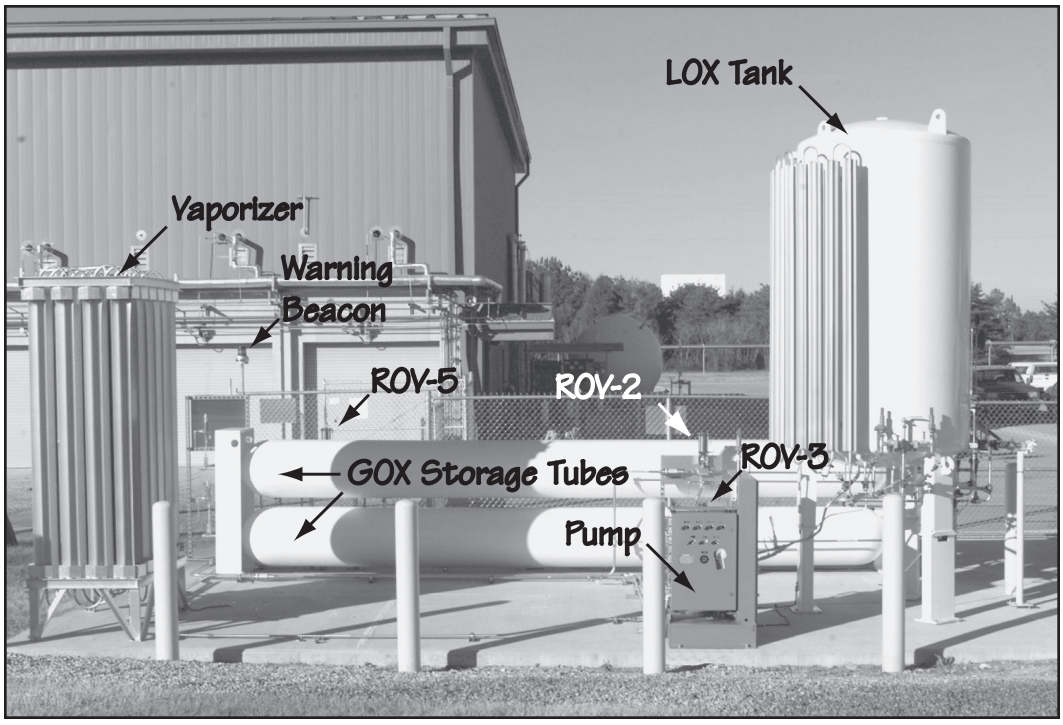


Figure 9-1.
Oxygen Supply System for Building 4623.

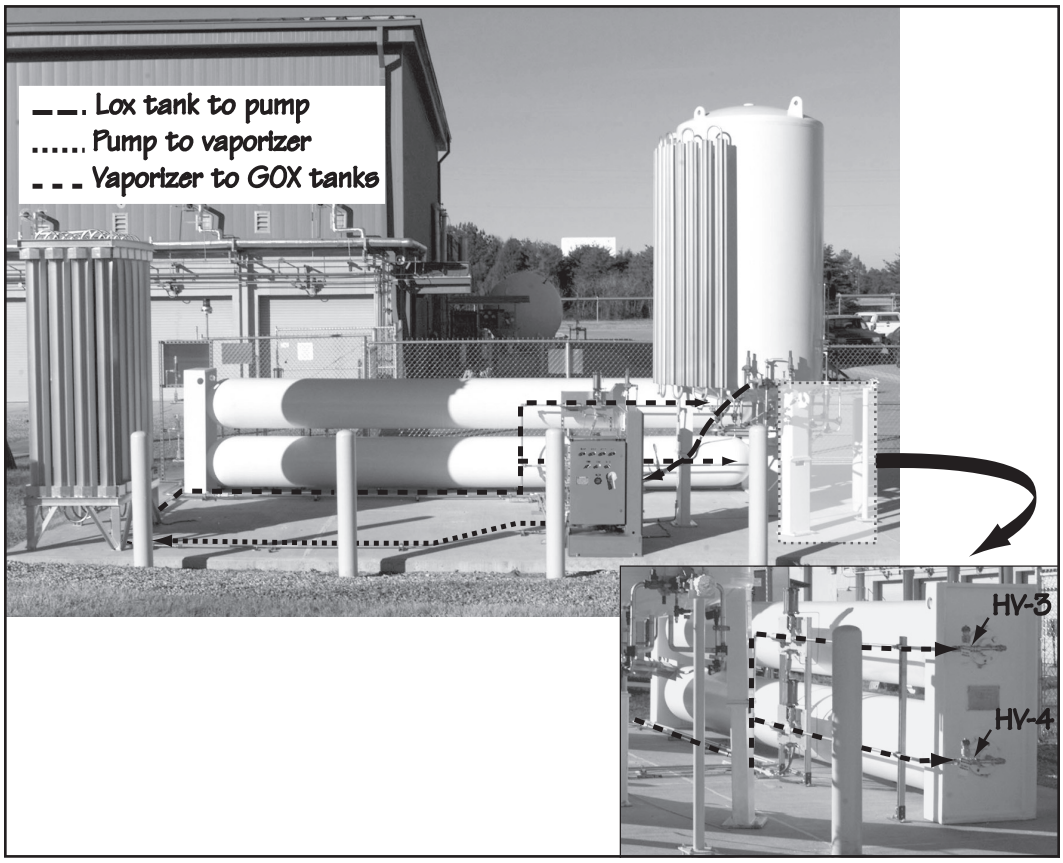


Figure 9-2.
Oxygen Flow from LOX Tank to GOX Storage Tubes.

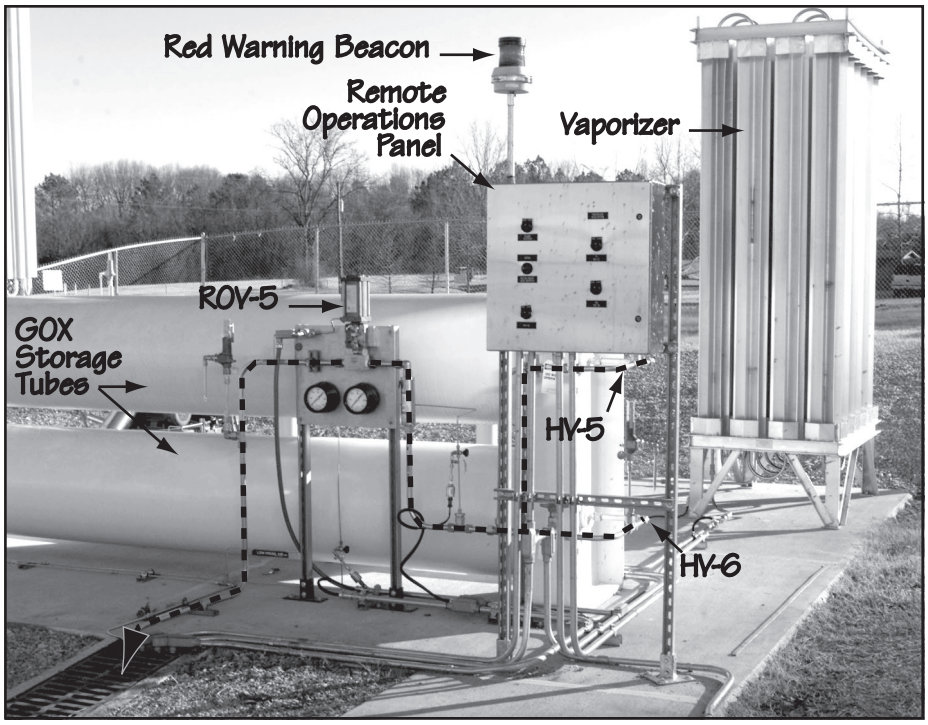


Figure 9-3.
Oxygen Flow from GOX Storage Tubes to Building 4623.

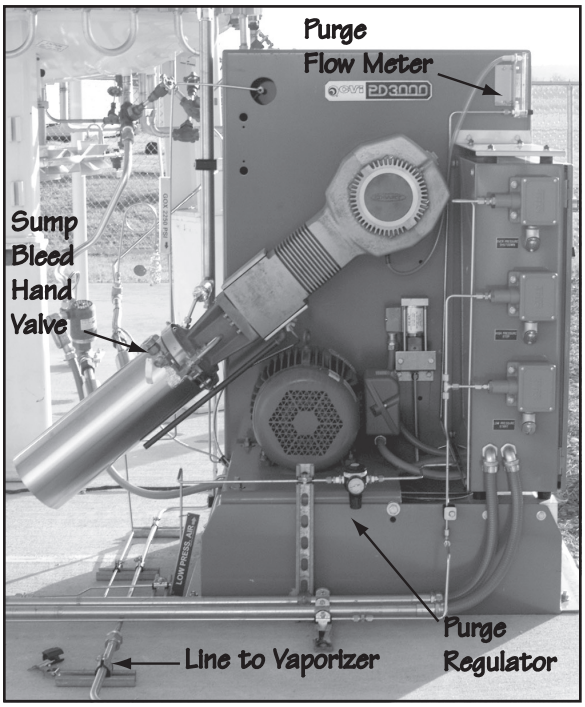


Figure 9-4.
LOX Pump

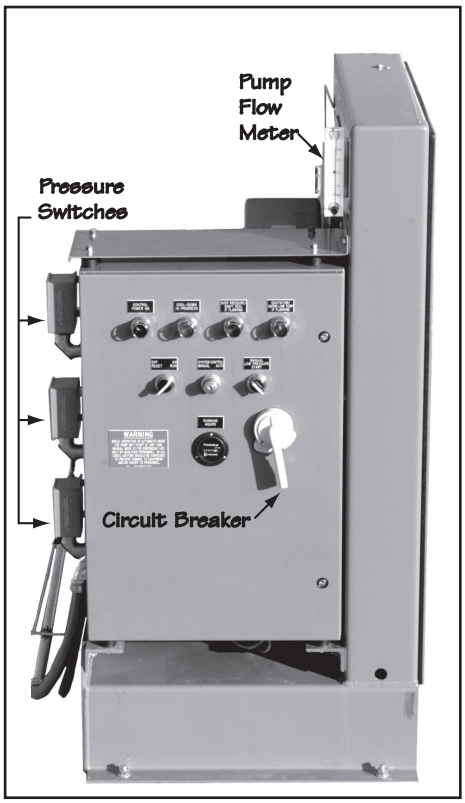


Figure 9-5.
LOX Pump Control Panel

9.1.4. GOX Storage Tubes (Figures 9-1, 9-2, and 9-3). The storage tubes are 24-in. (OD) seamless steel vessels with swaged ends, mounted one above the other in an "I" beam assembly. The design pressure of each tube is 2800 psi.

9.1.5. Control Panels. Three panels (two in the fenced area and one inside Building 4623) provide access to and control of system operations: the LOX Pump Control Panel (Figures 4-2 and 9-5), the Remote Operations Panel (Figure 9-3), and the Oxygen Supply Master Control Panel (Figure 4-3).

9.2 Procedure for Deviations

Deviations to the baselined oxygen supply system configuration shall require NASA written approval. It is the responsibility of the MSFC propellants and pressurized systems service contractor to obtain the written approval. *If the system configuration has been modified,* the system may require recertification.

9.3 Required Maintenance

9.3.1. The standard maintenance program involves a maintenance log, calibration, and a required spare parts inventory.

9.3.2. Relief Valve Maintenance

The standard maintenance program for the oxygen supply system and related equipment is performed in accordance with MPR-8823.2, *Pressure Systems Guidelines and Certification Requirements,* which directs that relief valves shall be verified every 5 years, at a minimum.

9.3.3. Filter Maintenance

The filter system shall be monitored daily by observation of pressure differentials across the MGO-F-4 filter (on Panel #2 on the pad) as well as the pressure differentials across filters between the GOX system and the individual operational test cells. *If a pressure differential across MGO-F-4 greater than 20% is noted,* the oxygen supply system shall be shut down immediately for filter check and filters shall be changed out as required.

In addition, a filter cleanliness check, including a check of the LOX inlet filter, shall be conducted annually, and results shall be recorded in the maintenance log. This record shall document filter operational efficiency.

9.3.4. Gas Sampling. The gas entering Building 4623 from the GOX supply system shall be sampled annually, analyzed, and certified by the Environmental Gas Laboratory. The results of this analysis shall be recorded in the GOX system maintenance log.

9.4 Calibration

The facility GOX Supply Station has two pressure transducers installed on the GOX supply side of the system. These pressure transducers are equipped with an isolation valve and a 1/4-in. AN tee. Calibration shall be performed on-site by the NASA Calibration Facility.

9.4.1. When calibration is necessary, the system operator shall:

9.4.1.1. **Unlock** the Oxygen Supply Master Control Panel using the correct key.

9.4.1.2. **Locate** the PUMP START selector switch, and **place** it in the OFF position.

9.4.1.3. **Close** and **lock** the Oxygen Supply Master Control Panel, and **remove** the key.

9.4.1.4. **Unlock** the fenced area to allow access to the GOX supply station.

9.4.1.5. **Fully close** (turn clockwise) the isolation valve for the pressure transducer needing calibration.

9.4.1.6. Using a wrench, **slowly crack t**he cap on the calibration tee to relieve the pressure on the transducer. Once the pressure is relieved, **remove** the cap.

9.4.2. When calibration is necessary, the Calibration Facility personnel shall then:

9.4.2.1. **Purge** the calibration supply line with the calibration gas by slowly cracking the supply gas until a small amount of gas is heard coming from the supply line. **Maintain** this purge for approximately 7 seconds.

9.4.2.2. **Connect** the calibration supply to the calibration tee.

Note: This is an oxygen system; all equipment to be connected to this system shall be free of oil, dirt, *etc.,* that can contaminate the system. Calibration gas-shall be clean, dry nitrogen or a clean, compatible inert gas.

9.4.3. After calibration is complete:the Calibration Facility personnel shall:

9.4.3.1. **Vent** the calibration supply.

9.4.2.2. **Disconnect** the calibration supply line from the calibration tee.

9.4.4. The system operator shall then:

9.4.4.1. **Purge** the calibration tee by slowly cracking the calibration isolation valve (turning counterclockwise) until a small amount of gas is heard coming from the calibration tee. **Maintain** this purge for approximately 7 seconds.

9.4.4.2. **Close** the isolation valve (turning clockwise) and **replace** the calibration tee cap.

9.4.4.3. **Open** the isolation valve slowly (turning counterclockwise) until it is in the full open position.

9.4.4.4. **Secure** and **lock** the fenced area around the GOX supply station.

9.4.4.5. **Open** the Oxygen Supply Master Control Panel using the correct key.

9.4.4.6. **Place** the PUMP START switch in the RUN position.

9.4.4.7. **Close** and **lock** the Oxygen Supply Master Control Panel.

9.5 Required Parts Inventory

Not applicable.

10.0 Personnel Training

The nature of testing that occurs in Building 4623, is complex and involves potential hazards; therefore, all GOX system operators shall hold **Category 1** credentials before performing oxygen supply system operations.

To be credentialled for basic operations (Category 1), an operator **shall complete** training in the following areas:

- High Pressure Systems Safety
- Safe Handling of Cryogenic Fluids (LN_2 and LOX)
- Oxygen Compatibility.

Category 1 Credential also require an annual physical examination conducted by the medical facility at Marshall Space Flight Center (or equivalent), including a hearing exam.

The operator **shall demonstrate** knowledge of the oxygen supply system and equipment by completing two successful system startups under the supervision of the test engineer. In addition, the operator **shall show proficiency** in performing the emergency shutdown procedure.

GOX system operators **shall read** this OWI thoroughly as part of the credentialling process. They **shall sign** a statement that they have read and understand the OWI and **shall be issued** personal copies of the OWI. The test engineer **shall give** the candidate a written test covering the OWI. A copy of this test, along with the signed statement and the training record, **shall constitute** verification of credentials. Training records **shall be kept** on file as proof of training. These records **shall include** training expiration dates and required refresher courses.

Credentials **shall expire** after a period of 2 years. After that time, recredentialling **shall be required.**

EMERGENCY PHONE NUMBERS

Emergency..... 911
Cell Phone..... 544-4357

Medical Center..... 4-2390

Industrial Safety..... 4-0046

Chemical Spills..... 4-4357

Safety Monitor
Building 4623..... 5-0358

Building 4623
Oxygen Supply System

! This Instruction Contains Descriptions of **HAZARDOUS OPERATIONS** !

Materials and Processes Laboratory
Materials Test Branch, Building 4623

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Release Authority	Name	Title	Organization	Date
Office of Primary Responsibility	[s] Gail H. Gordon	Materials Test Branch Chief	EM10	11/15/05
	[s] Dennis Davis	Industrial Safety	QD50	11/16/05

CHECK THE MASTER LIST -- ONLY THE LATEST VERSION IS VALID

Revision	Date	Originator	Description	Affected Pages
Baseline	2/4/05	Eddie Davis	Document converted from ED36-OWI-057. Previous history retained in system as part of canceled or superseded ISO Document files.	All
A	11/17/05	Eddie Davis	Hazardous Operations notification added to cover	Cover, ii

This document baselines the Organizational Work Instruction (OWI) for the Oxygen Supply System in Building 4623. Any change to this OWI **shall be submitted** to and **approved** by the Materials Test Branch Chief, EM10. Revisions may be also be submitted to the concurring organizations listed below for review and concurrence by memo. The original OWI and all changes **shall be maintained** by EM10.

Concurring organizations:
EM10 COTR
Environmental Health, AD02M

Contents

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